EXAMINING THE EFFECTS OF PLYOMETRIC EXERCISES ON ATTACKING AND DEFENSIVE PLAYING ABILITY AND PHYSICAL FITNESS COMPONENTS OF WOMEN VOLLEYBALL PLAYERS

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Introduction

Back ground of the problem

Volleyball is a sport played by two teams consisting of 12 players each on a playing court, divided by a net. The object of the game is to send the ball over the net in order to ground it on the opponent's court and to prevent the same effort by the opponent. The team has three hits or contacts to return the ball. To play volleyball one has to be good at the vertical jump, known as explosive power. A volleyball match can be played for five sets which means a match can last about 90 minutes ,during which a player can perform 250 -300 actions dominated by the explosive type of strength of the leg muscles. The total number of actions as jumps takes up around 50-60% high speed movements and change of direction in space about 30% and as falls about 15%. The spike and block actions are dominated by the corresponding explosive type of strength which is referred to as a player's vertical jump which is usually the key to winning point. Volleyball is a dynamic, fast-paced game.

Plyometric exercises enable the athlete to overload and train his/her body in a specific position required for a specific competition situation. Today the high level of professional sport focuses on specific training and plyometric training is a form of overload exercise.

Plyometric exercises, in conjunction with a weight-training programme, can lead to the execution of specific aspects of exercises (Siff & Verkhoshansky, 1993).

Wilson, Murphy and Giorgi (1996) as well as Bosco (1985) state that plyometric exercises can increase participants' ability to use elastic energy. Researchers state that plyometric exercises can change the elasticity of muscles and tendons, to enable them to store bigger quantities of elastic energy during a given stretch-shortening

movement. The faster the execution of the plyometric activity, the more elastic energy gets stored when the muscles and tendons are stretched to produce more power. In this way the delay between the stretch-shortening cycle is minimal causing maximum energy storage. Another advantage of plyometric exercises is that it includes movements, which cause elastic energy to maximize the stretch-shortening cycle (Blazevich, 2003).

Plyometrics, also known as "jump training" or "plyos", are exercises that muscles exert maximum force, with the goal of increasing power (speed-strength). This training focuses on learning to move from a muscle extension to a contraction in a rapid or "explosive" manner, such as in specialized repeated jumping. Plyometrics are primarily used by athletes, especially martial artists, sprinters and high jumpers, to improve performance, and are used in the fitness field to a much lesser degree.

Plyometrics includes explosive powerful training exercises that are trained to activate the quick response and elastic properties of the major muscles in the body. It was initially made famous by Soviet Olympians in the 1970s, providing the core element in the strength programs of elite sporting athletes worldwide. Sports using plyometrics include Volleyball, tennis and volleyball as well as the various codes of football.

The term "plyometrics" was coined by Fred Wilt after watching Soviet athletes prepare for their events in track and field; he felt this was a key to their success.He began a collaboration with trainer Michael Yessis of Soviet (Russia)to promote plyometrics.

Since its introduction in the early 1980s, two forms of plyometrics have evolved. In the original version of plyometrics, created by Russian scientist Yuri Verkhoshansky, it was defined as the shock method. In this, the athlete would drop down from a height and experience a "shock" upon landing. This in turn would bring about a forced eccentric contraction which was then immediately switched to a concentric contraction as the athlete jumped upward. The landing and takeoff are executed in an extremely short period of time, in the range of 0.1–0.2 second. The shock method is the most effective method used by athletes to improve their speed, quickness, and power after development of a strong strength base.

The second version of plyometrics, seen to a great extent in the United States, relates to doing any form of jump regardless of execution time. Such jumps cannot be considered truly plyometric (as described by Verkhoshansky) since the intensity of execution is much lower and the time required for transitioning from the eccentric to the concentric contraction is much greater. The term plyometrics became very popular with the publication of many books on the subject matter. It now appears impossible to go back to its original meaning and method of execution

Technique of jumping is also very important when executing plyometric exercises. In essence, the athlete goes into a slight squat (crouch) upon landing in which the hip, knee, and ankle joints flex. The takeoff or jump upward is executed in a sequence initiated by hip-joint extension followed by knee-joint extension which begins during the hip-joint extension. As the knee-joint extension is taking place, ankle-joint extension begins and is the only action that occurs as the takeoff (breaking contact with the ground) takes place. All three actions contribute force to the upward jump, but the knee-joint extension is the major contributor.

The most common type of plyometrics used in the United States is simple and relatively easy jump exercises executed with little regard to execution time. These jumps are effective for athletes who execute skills in their sport that do not require explosive type muscular contractions. An example is long-distance running in which the runners execute repeat actions of 20 to 30 consecutive jumps and other cyclic-type activities such as leaping for multiple repetitions.

Such plyometric jumps are also used as a warm-up for doing explosive plyometric jumps and for initial preparation of the muscles prior to undertaking exercises such as depth jumps. In essence, they are effective in the early stages of learning how to do plyometric exercises and for preparing the muscles for explosive or quick jumps. These jumps are similar to those done by youngsters in the playground or in neighborhood games and as such, do not require additional preparation. Athletes, regardless of their level of expertise, can undertake such jumps in the initial stages of training.

Jump technique remains the same regardless of whether it is a true plyometric exercise or a jump exercise. The hips, knees, and ankles flex when landing and the joints extend on the upward return. The sequence and overlapping in the sequence is

basically the same, beginning with the hip extension, followed by knee extension, and ending with the ankle-plantar flexing. The major differences in execution are the depth of the landing and the time of executing the switch from the eccentric to the concentric contraction.

HISTORY OF PLYOMETRIC

Plyometrics, when first developed in success-hungry Eastern European countries, was initially termed “jump training” (Chu, 1998). As Eastern Block successes in track and field events, gymnastics and weightlifting began to accrue, the training methods employed were scrutinized. In the West, plyometrics was referred to as the “Russian Training Secret”, a term that did not demystify the training system (Siff & Verkhoshansky, 1993). Initiated in Russia, since its scientific formulation as a discrete training system in the 1960’s, it was well established in the Eastern Block when the demand came for explosive power training. Verkhoshansky, the originator of the system, always favoured the term “shock” training to distinguish between naturally occurring plyometric action in sport and the effects of his discrete training methods (Chu, 1998). Much earlier sport physiological work used different terms to describe what is now termed “ plyometric”, the most popular being “stretch-shortening”. “Plyometrics”, as a training term, was wined in America, deriving from the Latin term meaning “measurable increases”. Plyometrics was responsible for the increasing competitiveness and growing superiority of Eastern Block athletes in track and field events (Chu, 1998). Driven by the success of the Eastern Block athletes, plyometric training became essential for all power athletes (Siff & Verkhoshansky, 1993). As a conditioning method, plyometrics became widely employed for the development of leg power (Young, 1991). Plyometrics is valuable due to the different ways in which muscle groups contract and are manipulated to maximize the “load up” before explosive movements (Blazevich, 2003; Kessel, 2002). As plyometric training became more valuable, other, less explosive, sports began employing plyometric concepts linked to their specific movements and activities. This gradual acceptance began in the late 1970’s, but only became widespread at the end of the 1980’s. This successful progress was retarded by the lack of plyometric expertise in American coaches, who believed that there must be a “better alternative”. Once the quality of the plyometric exercises were accepted, the quality rather than the quantity, was emphasised (Chu, 1998).

During the 1980's much effort has been expended in reproving the efficacy and safety of plyometric training. Some mixed results have been reported, although many of the problems might have been generated by comparing trained national and untrained athletes under variable conditions. Most poor results can be attributed to the fact that athletic development follows its own time curve, which cannot easily be reflected in short-term programmes, when development may occur throughout a whole athletic career. For some, this time span may be as short as a single season, for others it may be thirty years of competitive activities. Bearing this in mind, the athlete's skill, injury history and many other variables can compromise long-term athletic development. Realistic expectations for plyometric training can, thus, only be learned as a result of applied research (Chu, 1998).

Statement of the problem

"Examining the effects of plyometric exercises on attacking and defensive playing ability and physical fitness components of women volleyball players"

Objectives of the study

The following objectives of the are as :

1. The objective of the study was to examine the effect of plyometric exercise on the attacking and defensive playing ability of women volleyball players
2. The objective of the study was to examine the effect of plyometric exercise on the physical fitness components of women volleyball players.

Hypothesis

The following hypothesis of the will be formulated for the present study

1. There would be significant effects of plyometric exercise on the attacking and defensive playing ability of women volleyball players.
2. There would be significant effects of plyometric exercise on the physical fitness components of women volleyball players.

Delimitation of the study

1. The study was delimited to the Volleyball players only .

2. The study was delimited to 100 Volleyball players and divided into two group.
3. The geographical area was delimited to the jurisdiction of Chandrapur district of Maharashtra only.
4. The period of training programme was delimited to 12 weeks and 4 days per week.

LIMITATIONS OF THE STUDY

There are a number of limitations restricting the generalize ability of this study are as

1) Since the trainees belong to different level of performance hence the prior Experience of the players may be considered as limitation of the study.
2) Since the trainer belonged to different training this may be also considered as Limitation of the problem.
3) There was no control of research scholar on the diet of the subjects.
4) The effect of weather conditions was considered as limitations.
5) No motivation techniques were used during administrating the test.
6) A limitation of this study is that it reflects the findings of some young adults; the data was collected in selected population, the results may not be generalized to country.
7) The small sample size of each group had a limiting effect on the statistical power that restricted the ability to detect small differences, as well as non-significant changes.
8) The subjects were not always able to exercise at the same time of the day, due to preparation for mid-year examinations. Sometimes the exercise sessions took place in the early mornings and at other times in the late afternoons, which had an effect on their motivation for exercise.

DEFINITION AND EXPLANATION OF IMPORTANT TECHNICAL TERMS

Plyometric exercise

Plyometric exercise is a specific exercise regime that is needed to develop muscles that

contract maximally in the shortest possible time . Plyometric training is also defined as quick, powerful movements, which lead to the activation of the stretch-shortening.

CHAPTER II

REVIEW OF RELATED LITERATURE

Matavulji *et al.* (2001) looked into the effect of plyometric training on the jumping performance of junior Volleyball players. Although the plyometric training has showed its efficiency, it remains generally unknown whether a limited amount of plyometric training could improve movements in subjects who already demonstrate a high level of performance. While the control group participated only in regular midseason training activity, the other two groups performed a limited amount of plyometric training, employing drop jumps from the height of either 50 cm, or 100 cm. The heights of the maximal vertical jump, as well as the maximal voluntary force and the rate of force development of the hip and knee extensors were tested prior to as well as after the training. An increase in the maximal vertical jump, as well as maximal voluntary force of the hip extensors and rate of force development of the knee extensors was observed in both experimental groups, while no significant changes were recorded in the control group.

Matavulji *et al*. (2001) concluded that a limited amount of plyometric training could improve jumping performance in elite junior Volleyball players and that the improvement could be partly related to an increase in the force of the hip extensors and rate of force development of the knee extensors. The results obtained generally support the concept that plyometric training, employing drop jumps, could be a powerful tool to improve jumping performance even in high level athletes.

Brown *et al.* (1986) examined the effect of plyometric training on the vertical jump capability of male high school Volleyball players (N=26). These players were randomly assigned to an experimental training group (the plyometric group) and a control group. The experimental training group performed three sets of ten depth jumps, three days per week for twelve weeks, whilst the control group only performed regular Volleyball training. Results showed that the plyometric group imshowed significantly ($p<0.05$) in the vertical jump with arm assistance compared to the control

group. Neither group differed significantly ($p>0.05$) in the vertical jump without arm assistance. In the plyometric group, 57% of the vertical jump gain was due to jumping skill improvement, and 43% was due to strength gain. Plyometric training appeared to enhance arm coordination.

Kemp (1998) three different training programmes, including a gymnasium programme, a plyometric and a combined gymnasium and plyometric programme, was implemented in order to see which of these programmes would have a positive effect on certain elements, relevant to netball players. These elements include speed, agility, suppleness, explosive power and strength. The results of this study showed that the combined programme would have a positive effect on the biomotor abilities of the netball players.

Diallo *et al*. (2001) investigated the effectiveness of plyometric training and maintenance training regarding physical performance of prepubescent soccer players. They maintained that stretch-shortening cycle exercises (plyometric exercises) were often used to improve leg muscle power and vertical jump performance in adults but limited information is available regarding the effect of such exercises on children.

Cossor, Blanksby and Elliot (1999) examined the effects of a plyometric training programme on freestyle tumble turns. Thirty-eight (38) age-group swimmers were assigned to a control group, which swam 1,5 hours, three times per week for twenty weeks, or an experimental group, which supplemented 1,25 hours of swimming with 15 minutes of plyometrics for the same time frame. The same coach conducted all swimming and plyometric sessions to ensure uniformity. Swimming performance was assessed from 50m time. Freestyle turning performance was measured by 2,5 m round trip time (RTT), 5 m RTT, wall contact time and selected kinematic and kinetic variables associated with the turn. A plypower system was also used to test jump height and velocity. No significant differences between the groups (pre-, mid- and post-intervention) were found over the period of the study, for any swimming, kinetic or plypower measures. It is concluded that equal benefits were derived from normal practice time in water or land-based plyometric exercises.

Ebben et al, (2010). evaluated the plyometric training is effective for women, and performance is not influenced by the length of post training recovery - effectiveness of a periodized plyometric training program and the impact of the duration of the post-training recovery period on countermovement jump performance. no significant difference was for jump height or peak power from pre- to post test for the control group.

Solanikidis et al, (2008). was to determine the effectives of plyometric, tennis drills and combined on reaction lateral and linear speed, power and strength in novice tennis players. There was a significant difference in lateral speed (side-steps) between the 2 sides PT improved fitness characteristics that rely more on reactive strength and powerful push-off of legs such as, lateral reaction time, 4-m lateral and forward sprints, drop jump and maximal force. TDT improved all 4-m and 12-m sprint performances, whereas CT appeared to incorporate the advantage of both programs and improved most tests items.

Markovic G, et al, (2007) was to evaluate the effects of sprint training on muscle function and dynamic athletic performance and to compare them with the training effects induced by standard plyometric training . Male physical education students were assigned randomly to 1 of 3 groups : Both SG and PG significantly improved drop jump performance SJ and CMJ height ,and standing long jump distance, whereas the respective effect size ES were moderarate high ranged between 0.4 and 1.1 . in addition, SG also improved isomeric squat strength and SJ and CMJ power ,as well as sprintand agility Performance. short term sprint and athletic performance then does conventional plyometric training.

Kotzamanidis, C., (2006). was to investigate the effect of plyometric training on running velocity (RV) and squat jump (SJ) in prepubescent boys. Fifteen boys followed a 10 weeks plyometric program (JUMP group). Another group of 15 boys followed only the physical education program in primary school and was used as the control group. Running distances, were selected as testing variables to evaluate the training program. There was no change in either RV or SJ for the CONT group. These results indicate that plyometric exercise can improve SJ and RV in pre pubertal boys' .more specifically; this program selectively influenced the maximum velocity phase, but not the acceleration phase.

Toumi H, Best et al, (2004). was to compare the effects of plyometric training on jump performance. Thirty males between the ages of 19 and 22 volunteered for the8-week experiment. Subjects were divided into the following three groups: training groups (1)(TG1) training

group2 (TG2) and control group (CG, n=6). Each of the 2 experimental groups underwent a unique training regimen. There was an increase in leg extension force, velocity and electrical activity for SJ and CMJ for the two training groups($P<0.05$). However, TG1 showed a significant advantage in CMJ performance as well as a significant decrease in TR compared to the TG2 ($P<0.05$). The results of this study show that when plyometric training performed with rapid stretch contraction, the CMJ jump height increase and the TR decrease.

Turner, Owings and Schwane, (2003). Was determine whether a 6-week regimen of plyometric training would improve running economy. Eighteen regular but not highly trained distance runners were randomly assigned to experimental and control groups. All subjects continued regular running for 6 weeks; experimental subjects also did polymeric training. Dependent variables measured before and after the 6 weeks period were economy of running on a level of treadmill at 3 velocities. The plyometric training improved economy. The vo2 max did not change with training. Plyometric training did not result in changes in jump height (or) efficiency variables that would have indicated improved ability to store and return elastic energy

Swanik et al, (2002). The purpose of this study is to find the effect of plyometric training of the shoulder internal rotators on proprioception kinesthesia and selected muscle performance characteristics in female swimmers. Kinesthesia demonstrated significant improvement for all test conditions after plyometric training. Significant gains in selected muscles performance characteristics included time to peak torque (60 degree/s and 240 degree/s), amortization time (450 degree/s) and torque decrement (240 degree/s). This study suggests that plyometric activities may facilitate neural adaptations that enhance proprioception, kinesthesia and muscle performance characteristics. Significant neuromuscular benefits may be attained if they are implemented earlier into shoulder rehabilitation programs.

Chatzinikolaou A, et al., (2010). investigated were to study the inflammatory and performance responses after an acute bout of intense plyometric exercise during a prolonged recovery period. Participants were randomly assigned to either an

experimental group that performed intense plyometric exercises or a control group that rested. The delayed on set of muscle soreness (DOMS), knee range of motion (KROM), creatine kinase (CK) and lactate dehydrogenises (LDH) activities, white blood cell count, C reactive protein (CRP), uric acid (UA), cortical, testosterone, IL-6, IL-1b strength (isometric and isokinetic), and countermovement (CMJ) and static (SJ) jumping performance were measured at rest, immediately post exercise and at 24, 48, 72, 96, and 120 hours of recovery. The results of this investigation indicate that performing an acute bout of intense plyometric exercise may induce short-term muscle damage and marked but transient inflammatory responses. results clearly indicate the need of sufficient recovery between successive plyometric exercises training sessions. Improving repeated sprint ability in young elite soccer players.

Khlifa, R, Aouadi, et al, (2010). investigated was to examine the effect of a standard plyometric training protocol with or without added load in improving vertical jumping ability in male Volleyball players. Twenty-seven players were randomly assigned to 3 groups: a control group (no plyometric training), plyometric training group (PG), and loaded plyometric group (LPG, weighted vests 10-11% body mass).

The results showed that SJ, CMJ, and 5JT were significantly improved only in the PG and LPG groups. The best effects for jumps were observed in LPG ($p < 0.01$), which showed significantly higher gains than the PG ($p < 0.05$). plyometric training program may result in greater vertical and horizontal-jump performances in Volleyball players.

Santos EJ, Janeira MA., et al, (2010). conducted on the Effects of Plyometric Training Followed by Detraining and Reduced Training Periods on Explosive Strength in Volleyball Players. All participants were assessed on squat jump, countermovement jump, Abalakov test, depth jump, mechanical power, and medicine ball throw at the beginning and at the end of the 10-week in-season plyometric training and on weeks 4, 8, 12, and 16 of the in-season detraining and reduced training periods. In the first phase of the study, the experimental group significantly increased all the assessed indicators ($p < 0.05$). plyometric training showed positive effects on upper- and lower-body explosive strength in adolescent male Volleyball players. These results highlight the unique power that Volleyball-specific training seems to have on the sustainability and maintenance of sport performance

Izquierdo *et al.(***2008)** examined the effect of 3 different plyometric training frequencies associated with 3 different plyometric training volumes on maximal strength, vertical jump performance, and sprinting ability. Forty-two students were randomly assigned to 1 of 4 groups No significant differences were observed among the groups in pertaining in any of the variables tested. No significant changes were observed in the control group in any of the variables tested at any point. Short-term plyometric training using moderate training frequency and volume of jumps (2 days per week, 840 jumps) produces similar enhancements in jumping performance, but greater training efficiency (;12% and 0.014% per jump) compared with high jumping (4 days per week, 1680 jumps) training frequency (;18% and 0.011% per jump). In addition, similar enhancements in 20-m-sprint time, jumping contact times and maximal strength were observed in both a moderate and low number of training sessions per week compared with high training frequencies, despite the fact that the average number of jumps accomplished in 7S (420 jumps) and 14S (840 jumps) was 25 and 50% of that performed in 28S (1680 jumps).

Diallo *et al.* **(2001)** conducted a study on the effects of plyometric training on physical performance in soccer players**.** Twenty boys aged 12-13 years were divided in two groups (10 in each): jump group (JG) and control group (CG). JG trained 3 days/week during 10 weeks, and performed various plyometric exercises including jumping, hurdling and skipping. Jumping power was assessed by using the following tests: countermovement jump (CMJ), squat jump (SJ), drop jump (DJ), multiple 5 bounds (MB5) and repeated rebound jump for 15 seconds (RRJ15). During this period no significant performance increase was obtained in the CG. After the 8-week of reduced training, except Pmax ($p<0.05$) for CG, any increase was observed in both groups.

Meylan *et al.* **(2009)** investigated the effects of in-season plyometric training within soccer practice on explosive actions of young players. In soccer, explosive actions such as jumping, sprinting, and changes of direction are essential to optimal performance not only in adults, but also in children's games. Fourteen children (13.3 +/- 0.6 years) were selected as the training group (TG) and 11 children (13.1 +/- 0.6 years) were defined as the control group (CG). All children were playing in the same league and trained twice per week for 90 minutes with the same soccer drills. The TG followed an 8-week plyometric program At baseline and after training, explosive

actions were assessed with the following 6 tests: 10-meter sprint, agility test, 3 vertical jump tests (squat jump [SJ], countermovement jump contact test and multiple 5 bounds test. Plyometric training
was associated with significant decreases in 10-m sprint time (-2.1%) and agility test time (-9.6%) and significant increases in jump height for the CMJ (+7.9%) and CT (+10.9%). No significant changes in explosive actions after the 8-week period were recorded for the CG. The current study demonstrated that a plyometric program within regular soccer practice improved explosive actions of young players compared to conventional soccer training only.

Ronnestad *et al.* **(2008)** compared the short-term effects of strength and plyometric training on sprint and jump performance in professional soccer players. Subjects in the intervention team were randomly divided into 2 groups. There were no significant differences between the ST+P group and ST group. Thus, the groups were pooled into 1 intervention group. The intervention group significantly improved in all measurements except CMJ, while the control group showed significant improvements only in PP20. There was a significant difference in relative improvement between the intervention group and control group in 1RM half squat, 4BT, and SJ. However, a significant difference between groups was not observed in PP20, PP35, sprint acceleration, peak sprinting velocity, and total time on 40-m sprint. The results suggest that there are no significant performance-enhancing effects of combining strength and plyometric training in professional soccer players concurrently performing 6 to 8 soccer sessions a week compared to strength training alone.

Thomas *et al.* **(2009)** compared the effects of two plyometrics training techniques on power and agility in youth soccer players. Twelve males from a semi-professional football club's academy were randomly assigned to 6 weeks of depth jump (DJ) or countermovement jump (CMJ) training twice weekly. Participants in the DJ group performed drop jumps with instructions to minimize ground-contact time while maximizing height. Participants in the CMJ group performed jumps from a standing start position with instructions to gain maximum jump height. Post training, both groups experienced improvements in vertical jump height and agility time and no changes in sprint performance. There were no differences between the treatment groups.

Chelly *et al.* ***(*2010)** investigated the effects of in-season short-term plyometric training program on leg power, jump- and sprint performance of soccer players. There was also a significant increase ($p < 0.05$) in thigh muscle volume, but leg muscle volume and mean thigh cross-sectional area remain unchanged. We conclude that biweekly plyometric training of junior soccer players (including adapted hurdle and depth jumps) improved

important components of athletic performance relative to standard in-season training. Accordingly, such exercises are highly recommended as part of an annual soccer training program.

Sampaio *et al.* **(2010)** compares the short-term effects of complex and contrast training (CCT) on vertical jump (squat and countermovement jump), sprint (5 and 15 m), and agility abilities in soccer players. Twenty-three young elite Portuguese soccer players (age 17.4 +/- 0.6 years) were divided into 2 experimental groups (G1, n = 9, and G2, n = 8) and 1 control group (G3, n = 6). Groups G1 and G2 have done their regular soccer training along with a 6-week strength training program of CCT, with 1 and 2 training sessions .wk, respectively. G3 has been kept to their regular soccer training program. Each training session from the CCT program was organized in 3 stations in which a general exercise, a multiform exercise, and a specific exercise were performed. results suggested that the CCT induced the performance increase in 5 and 15 m sprint and in squat jump. Vertical jump and sprint performances after CCT program were not influenced by the number of CCT sessions per week (1 or 2 sessions./wk). From the obtained results, it was suggested that the CCT is an adequate training strategy to develop soccer players' muscle power and speed.

Gabbett *et al.* **(2008)** investigated the time course of adaptations to training in young (i.e., <15 years) and older (i.e., <18 years) junior rugby league players. Fourteen young (14.1 +/- 0.2 years) and 21 older (16.9 +/- 0.3 years) junior rugby league players participated in a 10-week preseason strength, conditioning, and skills program that included 3 sessions each week. Subjects performed measurements of standard anthropometry (i.e., height, body mass, and sum of 7 skin folds), muscular power (i.e., vertical jump), speed, agility (505 test), and estimated maximal aerobic power before

and after training. Improvements in maximal aerobic power and muscular endurance were observed in both the young and the older junior players following training. The improvements in speed, muscular power, maximal aerobic power, and upper-body muscular endurance were greatest in the young junior players, while improvements in lower-body muscular endurance were greatest in the older junior players. These findings demonstrate that young (i.e., <15 years) and older (i.e., <18 years) junior rugby league players adapt differently to a given training stimulus and that training programs should be modified to accommodate differences in maturational and training age.

Brown *et al.* **(2010)** analyzed the oxygen consumption, heart rate, and blood lactate responses to an acute bout of plyometric depth jumps in college-aged men and women. Plyometric depth jumping elicited 82.5 +/- 3.1% and 77.8 +/- 3.1% of the measured maximal oxygen consumption (O2max) for women and men, respectively, with no difference in oxygen consumption in ml/kg/min or percent O2max between sexes or sets. Heart rate significantly increased ($p < 0.05$) from 68.1 +/- 2.9 beats x min-1 at rest to 169.6 +/- 1.2 beats x min-1 during depth jumping. Plyometric depth jumping significantly increased oxygen consumption, heart rate, and blood lactate in both men and women, but no significant difference was found between the sexes. Plyometric depth jumping from a height of 0.8 m has similar energy system requirements to what Wilmore and Costill termed "Aerobic Power" training, which should enhance O2max, lactate tolerance, oxidative enzymes, and lactate threshold.

Newton *et al.* **(2010)** experimented the influence of plyometric training on strength performance. Majority of the research suggests plyometric training (PT) improves maximal strength performance as measured by 1RM, isometric MVC or slow velocity isokinetic testing. In order to optimize strength enhancement, the combination of different types of plyometrics with weight-training would be recommended, rather than utilizing only one form ($p<0.05$). The responses identified in this analysis are essential and should be considered by the strength and conditioning professional with regard to the most appropriate dose-response trends for PT to optimize strength gains.

Avery *et al.* **(2010)** conducted a study on the effects of a short-term plyometric and resistance training program on fitness performance in boys age 12 to 15 years. This study compared the effects of a six week training period of combined plyometric and resistance training (PRT, n = 13) or resistance training alone (RT, n = 14) on fitness performance in boys (12-15 yr). The RT group performed static stretching exercises followed by resistance training whereas the PRT group performed plyometric exercises followed by the same resistance training program. The training duration per session for both groups was 90 min. At baseline and after training all participants were tested on the vertical jump, long jump, medicine ball toss, 9.1 m sprint, pro agility shuttle run and flexibility. The PRT group made significantly ($p < 0.05$) greater improvements than RT in long
jump (10.8 cm vs. 2.2 cm), medicine ball toss (39.1 cm vs. 17.7 cm) and pro
agility shuttle run time (-0.23 sec vs. -0.02 sec) following training.

Michael *et al*. **(2006)** assessed the effects of 6-week plyometric training program on agility. Subjects were divided into two groups, plyometric training and a control group. The plyometric training group performed in a six week plyometric training program and the control group did not perform any plyometric training techniques. All subjects participated in two agility tests: T-test and Illinois Agility Test, and a force plate test for ground reaction times both pre and post testing. Univariate ANCOVAs were conducted to analyze the change scores (post – pre) in the independent variables by group (training or control) with pre scores as covariates. The result revealed a significant group effect $F2, 26 =$
25.42, $p=0.0000$ for the T-test agility measure. For the Illinois Agility test, a significant group effect $F2, 26 = 27.24$, $p = 0.000$ was also found. The plyometric training group had quicker posttest times compared to the control group for the agility tests. A significant group effect $F2, 26 = 7.81$, $p = 0.002$ was found for the Force Plate test. The plyometric training group reduced time on the ground on the posttest compared to the control group. The results of this study show that plyometric training can be an effective training technique to improve an athlete's agility.

Rahim *et al.* **(2005)** examined the effects of plyometric, weight and plyometric-weight training on anaerobic power and muscular strength series. The study compared

the effects of 3 different training protocols-plyometric training, weight training, and their combination on the vertical jump performance, anaerobic power and muscular strength. Based on their training, forty-eight male college students were divided into 4 groups: a plyometric training group (n=13), a weight training group (n=11), a plyometric plus weight training group (n=14), and a control group (n=10). The vertical jump, the fifty-yard run and maximal leg strength were measured before and after a six-week training period. Subjects in each of the training groups trained 2 days per week, whereas control subjects did not participate in any training activity. The results showed that all the training treatments elicited significant ($P<0.05$) improvement in all of the tested variables.

Chelly *et al.* **(2009)** investigated the effects of voluntary maximal leg strength training on peak power output, vertical jump performance, and field performances in junior soccer players. Twenty-two male soccer players participated in this investigation and were divided into 2 groups: Both typical force-velocity relationships and mechanical parabolic curves between power and velocity increased after the strength training program. Leg and thigh muscle volume and CSA of RTG remained unchanged after strength training. Back half squat exercises, including adapted heavy loads and only 2 training sessions per week, improved athletic performance in junior soccer players. These specific dynamic constant external resistance exercises are highly recommended as part of an annual training program for junior soccer players.

Chapter III

Methodology

This chapter explained the methodological details used to implement the study.

Demographic Information

The data will be collected through respondents in the form of different tests. The demographic information about, age, height, weight etc. will be obtained before seeking training from Volleyball players.

Sampling Method:

Purposive sampling method will be used, as the researcher selected Volleyball Players with a specific purpose.

Target of population

Two groups will be targeted, experimental group (plyometric exercise group) and control group . 50 Volleyball players selected under plyometric exercise group and 50 Volleyball players control group. Training will be given to experimental group only.

Research design:

The design in a research study refers to the researcher's overall plan for answering the researcher's question or testing the research hypotheses. This study involves a cross sectional, comparative pre and post-test of experimental and control group. This study will be conducted in an experimental design.

f) Body Mass Index:

Body Mass Index will be measured by individual's body mass divided by the square of his height.

Tools of the study:

Stopwatches, still tape, electronic blood pressure device, weighing machine, stadia-meter, Spiro-meter, and health outcome questionnaires tools will be used for data collection.

Plyometrics :

The Plyometric exercise programme will be planned for 4 days a week 30 minutes in a day for 12 weeks including 10 minutes warm up period and 05 minutes cooling down. The following plyometric exercise will be taken for Volleyball players.

1. **Front Box Jump**

The Front Box Jump is one of the most-used plyometric exercises because it is very effective at increasing one's vertical jump. It strengthens quadriceps and glute muscles, which are essential for jumping.

Procedures of test:

1. Place a plyo box 6 inches in front of you.
2. Get into a squat position with your feet about shoulder-width apart.
3. Squat and explode up using your entire body, including your arms.
4. Land softy on the box on the balls of your feet.
5. Step down, reset yourself and repeat.
6. You can either increase box height or add weight via weighted vest, barbell or dumbbells to increase the difficulty.

Lateral Box Jump

The Lateral Box Jump requires the muscles to contract in a slightly different manner. This is beneficial, because in most cases athletes jump not just forward but also laterally when playing their sports.

Weighted Lateral Jumps

Similar to Lateral Box Jumps, this plyometric exercise builds lateral leaping ability and strength. It also strengthens the ankles and calf muscles. This movement focuses more on quick feet and agility.

Procedures of test:

1. Place a barbell on the ground with a weighted plate on each side.
2. Adjust the weighted plate size according to your jumping ability—the bigger the weight, the higher the bar.
3. Stand about 6 inches to the side of the barbell.
4. Hold a weighted plate or medicine ball over your head. Adjust the weight according to your ability.
5. Bend your knees slightly with your feet close together.
6. Hop over the bar and back continuously, staying light on your feet.

Sets/Reps: 3x15 (over and back counts as one rep)

Broad Jumps

Broad Jumps build true leg strength, because you don't take a first step or get a running start. They require you to perform a deep Squat to propel yourself forward as far as you can, using your quadriceps and glute muscles.

Procedures of test:

1. Use a surface that has some give to it.

2. Get into a squat position with your feet shoulder-width apart facing an open space.

3. Squat down deep and explode up, using your entire body to thrust yourself forward.

4. Land softly on the ground and immediately transition into your next rep.

Skater Jumps

Skater Jumps build lateral strength and power in the quadriceps and glute muscles. They also place the entire load on one leg, which helps with balance and reduces the tendency to favor the stronger leg during two-legged jumps.

Procedures of test:

1. Get into a squat position with your feet close together and the majority of your weight on your right leg.

2. Push off your right leg to the opposite side.

3. Land softly on your left leg and move your right leg behind it like you will be performing a Curtsy Lunge.

4. Repeat on your left leg. That's one rep

Scissor Jumps

This plyometric exercise is essentially a Jumping Lunge in place. Scissor Jumps increase adductor and glute muscle strength with the legs in a stretched position.

Procedures of test:

1. Get into a standard lunge position, keeping your back straight and your knees and toes forward.

2. Squat down and explode up, switching leg positions in mid-air.

3. Land softly and immediately transition to your next jump.

4. Perform the same movement, switching your leg position each time.

Dot Drill

The Dot Drill increases foot speed and quickness. It also increases ankle and calf strength, like Weighted Lateral Jumps.

Procedures of test:

1. Place a dot mat in front of you or mark five spots like dots on a dice.

2. Start with your feet on the two corner dots at the front end of the mat.

3. Hop slightly off the ground, bringing both your feet together on the middle dot.

4. Without stopping, jump slightly and separate your feet so each foot lands on a corner dot at the far end of the mat.

5. Repeat the movement in reverse. That's one rep.

6. Repeat 10 times.

7. The second sequence is the same as the first, except once you reach the far end of the mat moving forward, turn around and repeat the movement going forward instead of in reverse.

8. Perform that sequence 10 times.

9. The third sequence requires you to hop to each dot on one leg.

10. Start from the dot in the front right corner.

11. On one leg, hop to the middle dot, then the far right dot, then the far left, then hop backwards to the middle dot, then to the front left, and back to the front right. That's one rep. Repeat 10 times.
12. Perform the same sequence on the other foot 10 times, and then 10 times using both feet close together.

Lateral Box Shuffles

These mimic Skater Jumps but they focus more on lateral foot speed and quickness than explosive strength.

Procedures of test:

1. Place a plyo box to the side at about shin height.

2. Stand on the box with your right leg. Keep your left foot on the floor about 6 inches away.

3. Get into a squat position and lift your left foot up onto the box while simultaneously placing your right foot on the floor on the other side of the box.

Sets/Reps: 3x30

Barbell Squat Jumps

This exercise adds weight to normal Bodyweight Squat Jumps, making it more difficult. When you perform a normal jump, it seems much easier and you can jump higher by increasing your explosive strength and power. Do not add so much weight that you are unable to perform a good jump.

Procedures of test:

1. Set up a free-weight squat rack, adding weight to the barbell that allows you to perform 10 repetitions.

2. Lift the barbell off the rack and get into a squat position with your feet about shoulder-width apart.

3. Squat down and explode up, jumping off the ground.

4. Land softly and immediately transition into your next rep.

Medicine ball chest pass test

Purpose:

To determine the explosive power and power of the individual's upper body.

Equipment:

Medicine ball (3 kg)

Procedure:

The subject had to sit with legs straight and back against a perpendicular wall. The player then began by holding the 3 kg medicine ball with both hands at chest level, elbows pointing outwards. The ball will be passed forward in a straight line, as hard as possible, in an explosive movement. The distance that the ball will be thrown will be measured from the wall against which the player will be sitting (Tenke & Higgins, 1996).

Scoring:

The distance the individual pushes the 3 kg medicine ball will be used as the score for the chest pass. Each individual got two chances, and the further distance will be recorded.

Depth jump:

In depth jump mainly quadriceps (thigh), hamstrings, gluteus (buttocks), calf Muscles are involved. For doing depth jump ankle extension, knee extension, hip extension these Joint movements are required. Depth jump is applicable to Running and jumping based sports such as tennis, football, Volleyball and high jump etc. for doing depth jump participants will be stood on top of a strong platform, its height will be 0.5m to 0.8m. Then he stepped slightly forward off of the platform. After that participant will be land toward his forefeet; then reacted as quickly as possible to the ground and jump immediately back up into the air. Participant used his arms to add to speed by drawing them back prior to stepping off the platform and swinging them vigorously upward, as his feet touched the ground. Kept his back in neutral alignment, i.e. not arched or rounded. Repeated this action.

PHYSICAL FITNESS ASSESSMENT

F) Administration of Tests

Pre and Post-tests will be applied on experimental group's to measure physical fitness components.

The following tests will be taken for measuring physical fitness of selected collegiate students from experimental group.

Cardiovascular Endurance:

This component will be evaluated by using 12 minute Run & Walk Test.

The 12 minute run test requires the person being tested to run or walk as far as possible in a 12 minute period. The objective of the test is to measure the maximum distance covered by the individual during the 12 minute period and is usually carried out on a running track by placing cones at various distances to enable measuring of the distance. A stopwatch is required for ensuring that the individual runs for the correct amount of time. When time is over, at that time investigator gives signal to stop.

Subject will be stands right there where he stops. Then investigator measures the crossed distance by the subject.

Muscular Endurance:

This component will be evaluated by using 1 minute Bent Knee Sit Up test. Abdominal muscular endurance will be measured by performing the 1-minute bent knee sit-up test. Subject Lied on his back with knees bent at a 90-degree angle. His feet will be flat on the floor. Subject interlocked his fingers behind his head, and then slowly rises to sitting position and touched his elbows to knees. Now subject let down his body back to the starting position, and repeated the process as many times as possible for the subject within one minute.

MUSCULAR STRENGTH:

This component will be measured by using Grip Dynamometer & Kraus Weber Strength Test.

Grip Dynamometer Strength Test:

The muscle groups in forearm involve many extensor and flexor muscles. These two groups work together to provide grip strength, which is essential to performing everyday tasks and many sporting activities. The most common way to measure grip strength is with a handheld dynamometer. A dynamometer is a spring-loaded squeeze device that measures force and assesses muscle group strength. Procedure: The subject used his right hand and applied as much grip pressure as possible on the dynamometer by squeezing the handle together. The maximum reading is recorded by the assistant. The test is repeated three times using the same right hand. The highest recorded value is used to assess the grip strength. Scoring: The highest recorded values for each hand are averaged together to get the total score. This score is then compared on a scale to determine your rating. The ratings are excellent, very good, above average, average, below average, poor and very poor.

Kraus Weber Strength Test:

This test is made up by combining six physical activities or tests. These are as follows: Test No. 1: The subject lied flat on back with his hands behind the neck, assistance held his feet on the ground, and performed one sit-up.

Test No. 2: The subject lied down with his knees will be bent, with his ankles close to the buttocks and performed one sit-up.

Test No. 3: The subject lied flat on back with hands behind neck. Legs straightly lifted 10 inches off the floor. Subject holds his position for 10 seconds.

Test No. 4: The subject lied on stomach with a pillow under his lower abdomen and groin. Assistant holds his feet down. Subject lifted head, shoulders, and chest off the floor and holds for 10 seconds.

Test No. 5: The subject's position will be the same, but the assistant holds the chest down, with straight knees, lift legs off floor and hold for 10 seconds.

Test No. 6: The subject stands erect. Subject keeps knees straight. Bend over slowly and touch the floor with the fingertips. Hold this position for 3 seconds.

Body Composition will be evaluated by using Body Mass Index (BMI).

Body Mass Index is calculated from body mass (M) and height (H). BMI = M / (H x H), where M = body mass in kilograms and H = height in meters. The higher score of the Body Mass Index usually indicates higher levels of body fat. **Scoring:** Use the BMI table to determine BMI rating. The rating scale is the same for males and females. You can also use the reverse lookup BMI table for determining your ideal weight based on height.

Flexibility:

This component will be measured by using Bend & Reach and Sit & Reach Test.

Bend & reach Test:

The main aim of this test is to evaluate the flexibility of the subject. For conducting the test a stable wooden box 40 Cm.'s. high on one side is requires. Procedure: Subject stands bare foot on the box with both feet together with toes in line with the edge of the box. From this position he bends forward and downward while keeping his knees straight. He extends his hands along the scale as down as possible. Both the hands should be parallel. At a maximum reach he holds the position for about 2 seconds. Scoring: The result is read from the scale. Two attempts are given at recovery rest of 30 seconds. In case a subject is not able to extend his hands even to the level of the box then the distance from the 0 Cm's. Mark to the tip of middle finger should be measured with a scale and recorded as negative score.

Sit & reach Test:

The main aim of this test is to evaluate the flexibility of the subject. For conducting the test a stable wooden box 40 Cm's. high on one side is requires. Procedure: Subject sits bare foot with the box with both feet together with toes in line with the edge of the box. From this position he bends forward and while keeping his knees straight. He extends his hands along the scale as forward as possible. Both the hands should be parallel. At a maximum reach he holds the position for about 2 seconds. Scoring: The result is read from the scale. Two attempts are given at recovery rest of 30 seconds. In case a subject is not able to extend his hands even to the level of the box then the distance from the 0 Cm's. Mark to the tip of middle finger should be measured with a scale and recorded as negative score.

Ethical Consideration:

In this research study the researcher Follow to ethical guidelines, principles, and standards for studies conducted with human beings .The study will be include safeguards for protecting humans,

The inclusion criteria are:

1. The participant will be agreeing to participate in the study.
2. The participants must be competitive young adults in their aged range will be 18 to 35 years.

3. The participants will be not rotating through other health facility at the time of study.

The exclusion criteria are:

1. The participants advised not to participate if under any physiological or psychological disorders.
2. Inability to obtain the questionnaire of the respondent.
3. Presence of chronic medical conditions such as asthma, heart disease or any other condition and
4. Participants not less than aged of 18 and more than 35 years

Volleyball playing ability test

The attacking and defencing playing ability test will be measure through Brady volleyball skill test, Russell and Lange volleyball skill test, Glady's scott and esther french's volleyball test, Kronqvist and brumbach volleyball test, Gabbett and georgieff volleyball skill test Bascaran Volleyball skill test and french cooper Volleyball test

Statistical technique:-

The statistical computation of data of the present study is used by using SPSS package in the computer. The result computed also crosschecked by using following statistical variables. Mean standard deviation, T-test. The level of significance will be set-up at 0.05 level of confidence to test the hypothesis.

Tentative Chapterization:

The present study will be divided in the following chapters:

Chapter - 1

The Chapter One outlines the background of the problem under consideration, its significance in the present scenario, the scope of the study, objectives the research intends to achieve and hypotheses to be established. This chapters also includes the definition and explanation of important technical terms related to the study.

Chapter - 2

The Chapter Two undertakes the review of literature related to the present topic of study and tries to define the problem under consideration in a proper way. Firstly, the

chapter defines important terms and concepts in a proper way to give readers an understanding of various terms in the research report. Secondly, it critically reviews the gender-based violence. The chapter identifies the research gaps between the problem under consideration and the available literature on the issues and strongly recommends further exploration on the problem.

Chapter - 3

This includes a detailed methodology of conducting research on the issue under consideration and various components of research design such as the universe, the sample, types of data, tools of data collection, technique of data collection, ethical consideration and methods use to analyse data.

Chapter - 4

The Chapter includes the interpretation of data and results of the study. The results of the study will be illustrated through suitable table and figure. This chapter will also include the discussion of findings.

Chapter - 5

The Chapter five summarizes the findings of the study and conclusions derived thereof. The research has also made some valuable suggestions for further research

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